upon which so-called primary cathode or β rays fall. The primary rays may be produced by any of the methods given above. The secondary rays may, by impinging on substances, give rise to tertiary rays, and so on.

To these may be added another way, which has been described by Professor Birkeland, namely, that cathode rays are sent out from a rarified gas when it is traversed by an electric current. This was demonstrated by means of a vacuum tube consisting of a large spherical bulb with two tubes of small bore sealed into it at right angles to each other and situated 90° apart on a great circle of the sphere. The electrodes were sealed into these tubes, and hence when a discharge was past the current entered the large bulb from the small opening in one of these tubes and had to leave it thru the similar opening of the other, the object being to get a current that should be confined to only a limited portion of the gas in the bulb. One of the tubes projected some distance into the bulb, and the path of the current when no magnet was brought near the bulb was approximately a straight line between the openings in the two tubes. With a suitably high vacuum a faint glow was seen thruout the whole volume of the bulb, besides the comparatively brilliant path of the current, and the walls of the bulb phosphoresced with a faint yellow light, indicating that they were being bombarded with cathode particles.

On bringing one pole of a very powerful electromagnet near the bulb, the path of the current was bent into a curve, and the glow which before filled the bulb was drawn up into a band whose surface contained the curved current and also the lines of magnetic force. These phenomena indicate that the cathode particles were sent out from the gas in the path of the current, and in a magnetic field their paths would, of course, be spirals around the lines of force.

The most natural assumption to make regarding the origin of the cathode rays sent out from the sun is that they are emitted by the photosphere itself since this is undoubtedly at a very high temperature. The objection to this is that such cathode rays could perhaps never penetrate the deep solar atmosphere which they would have to do in order to reach the earth. We do not know how dense the solar atmosphere is, but most estimates agree that near the photosphere it is very much denser than that of the earth, and since the β rays of radium, which are far more penetrating than ordinary cathode rays, are completely absorbed by a layer of gas of much smaller extent than our atmosphere, it follows that the solar atmosphere would effectually stop any negative electrons emitted by the photosphere.

Evidently, then, the source of the cathode rays demanded by Birkeland's theory must be lookt for high up in the solar atmosphere, where the density is extremely small. There are several ways in which cathode rays might originate even in the upper regions of the solar atmosphere where the density is sufficiently small to favor the ready escape of the particles into space. It seems, however, necessary to connect this emission of electrons in some direct way with the sun spots, or, more definitely, with the moments of great activity in a sun spot, and this limits the number of ways, by excluding the third one mentioned above. The first one is excluded because an extended rarified gas is too good a conductor to allow any strong electric fields to exist in it. The fifth may also be excluded for obvious reason.

There remain, then, the emission of cathode rays from the gas thru which a current flows, and the emission of β rays from radio-active substances. Such violent disturbances as are manifest in sun spots at times may well produce electric currents in the upper regions of the solar atmosphere, and if such currents really send out cathode rays of any considerable penetrating power, these might escape into space and so reach the earth.

Violently eruptive sun spots might also project into the upper regions of the sun's atmosphere certain radio-active material if it exists in the sun, which might emit β rays copiously enough to produce on the earth the phenomena of the aurora in accordance with Birkeland's theory.

THE WARM STRATUM IN THE ATMOSPHERE.[1]

By Prof. A. LAWRENCE ROTCH. Dated Blue Hill Meteorological Observatory, Hyde Park, Mass., April 24, 1908.

While not presuming to offer an explanation of the isothermal or relatively warm stratum in the high atmosphere which the recent letters in Nature have made known to others than meteorologists, I desire to point out that it is probably a universal phenomenon, existing at some height all around the globe. This inversion of temperature was first discovered by M. Teisserenc de Bort with the sounding balloons sent up from his observatory at Trappes, near Paris, France, in 1901, and almost simultaneously by Professor Assmann from similar German observations. Since then almost all the balloons which have risen more than 40,000 feet above central Europe (that is, near latitude 50°) have penetrated this stratum, without, however, determining its upper limit. Teisserenc de Bort early showed that its height above the earth, to the extent of 8,000 feet, varied directly with the barometric pressure at the ground. Mr. Dines[2] gives the average height of the isothermal layer above England as 35,000 feet, with extremes of nearly 50 per cent of the mean. Observations conducted last March by our indefatigable French colleague, Teisserenc de Bort, in Sweden, just within the Arctic Circle, showed that the minimum temperature occurred at nearly the same height as at Trappes, namely, 36,000 feet, altho Professor Hergesell, who made use of sounding balloons over the Arctic Ocean near latitude 75° N., during the summer of 1906, concluded that the isothermal stratum there sank as low as 23,000 feet.

During the past three years the writer has dispatched 77 sounding balloons from St. Louis, Mo , U. S. A., latitude 38° N., and most of those which rose higher than 43,000 feet entered the inverted stratum of temperature. This was found to be somewhat lower in summer, but the following marked inversions were noted last autumn: October 8, the minimum temperature of −90° F. occurred at 47,600 feet, whereas at the maximum altitude of 54,100 feet the temperature had risen to −72°; October 10, the lowest temperature of −80° was found at 39,700 feet, while −69° was recorded at 42,200 feet, showing a descent of nearly 8,000 feet in the temperature inversion within two days. The expedition sent out jointly by M. Teisserenc de Bort and the writer, on the former's steam yacht *Otaria*, to sound the atmosphere over the tropical Atlantic during the summer of 1906, launched sounding balloons both north and south of the equator within the Tropics, and altho some of these balloons rose to nearly 50,000 feet, they gave no indication of an isothermal stratum. In fact, the paradoxical fact was established that in summer it is colder 8 miles above the thermal equator than it is in winter at the same height in north temperate regions. This results from the more rapid decrease of temperature in the Tropics and the absence of the numerous temporary inversions which, as Mr. Dines has pointed out, are common in our regions below 10,000 feet. If, therefore, as seems probable, the isothermal or relatively warm stratum does exist in the tropical and equatorial regions, it must lie at a height exceeding 50,000 feet, from which height, as the data quoted show, it gradually descends toward the pole, at least in the Northern Hemisphere.

TORNADOES IN LOUISIANA, APRIL 24, 1908.

By I. M. CLINE, District Forecaster. Dated New Orleans, La., June 12, 1908.

An area of low pressure which was central over Utah on the morning of April 22 moved eastward and increased in inten-

[1] Reprinted from Nature, May 7, 1908.
[2] Nature, February 27, 1908, p. 390.